EFFECTS OF IMPROVEMENT ON SELECTIVE ATTENTION: DEVELOPING APPROPRIATE SOMATOSENSORY VIDEO GAME INTERVENTIONS FOR INSTITUTIONAL-DWELLING ELDERLY WITH DISABILITIES

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ABSTRACT
The purpose of this study was to develop appropriate somatosensory video game interventions on enhancing selective attention of institutional-dwelling elderly with disabilities. Fifty-eight participants aged 65~92 were recruited and divided into four groups, 4-week and 8-week experimental and two control groups, for evaluating the one-month carry-forward effects by Vienna Test System. Fourteen participants in experimental groups voluntarily completed 30-minute Xbox games 3 times per week for a total of 4 and 8 weeks. The results showed that: (1) except sum of incorrect reaction, a majority of participants whose selective attentions had significant improvements in immediate effect, carry-forward effects and overall effect in 8-week group ($p < .05$); (2) 5 out of 8 items in selective attention tests had significant immediate and carry-forward effects and one overall effect in 4-week intervention ($p < .05$) and (3) The results conclude that using somatosensory video games is a viable approach to promote selective attention of institutional-dwelling elderly with disabilities. The present study also found that this approach could motivate elderly to participate with a variety of sound, music and sensory stimulations and is a viable and valuable direction to promote quality of life in long-term care system.
Keywords: somatosensory video game, aging and aged, attention, Xbox Kinect

INTRODUCTION

Significance of Selective Attention of Elderly

The issue of an aged and ageing population is of international concern and considered one of the foremost challenges globally. According to UN investigation, aged and aging populations increase 2.6% every year and will be more than child population in 2045 (United Nation [UN], 2009). In Taiwan, more than 2 million older adults aged more than 65 years also old reached 10.7% of total population in 2010 (Directorate-General of Budget, Accounting and Statistics, Executive Yuan, 2011). Therefore, with this dramatically growing trend, the concept of health promotion for aged and aging population has been one of the significant issues to address in Taiwan. Among all health promotion concerns of older population, selective attention has been noticed in recent studies because its positive contribution on fall prevention (Liu-Ambrose, Nagamatsu, Hsu, & Bolandzadeh, 2012).

Somatosensory Video Game Interventions for Elderly

With the massive attentions of medical and allied health professions, somatosensory video games had changed its roles from “toys for fun” to “therapy tools for rehabilitation/health promotion”. Green and Bavelier (2003) stated that playing video games effectively increases players’ visual skills and attentions. Related research also identified that video games have positive outcomes on promoting short-term memory, selective attention and motivation for older adults (Gamberini, Barresi, Majer, & Scarpetta, 2008; Ijsselsteijn, Nap, de Kort, & Poels, 2007). Miller (2005) also used the “HiFi” video game on 95 health older adults (mean = 80 years old) and found the significant improvements on memory and attentions with one hour per day for 8 weeks. Therefore, this study

proposes to use a somatosensory video game to enhance selective attention of institutional-dwelling elderly with disabilities. Flynn and associates (2007) used a somatosensory video game, Eye Toy, in stroke patients and found that its significant impacts on assessments of physiological functions (Berg Scale, timed up and go, functional stretching, Dynamic Gait Index) and effectively improved upper and lower limbs coordination, motor recovery capabilities and reduced the levels of spasticity.

Recent studies also identified that somatosensory video games uses images, sounds and videos images to create dynamic and visual interactions also have strengths in improving cognitive function, visual performance skills, hand-eye coordination and reaction ability (Chiang, Tsai, & Chen, 2012; Liu, 2011; Rosenberg et al., 2010). Chiang and his associates (2004) began to use a somatosensory video game, Dance Dance Revolution, for older adults in the community and found that its effectiveness of balance improvements. With Bluetooth technology advances, the research team continued the study line by using Wii Fit to train institutionalized elder adults' balance and also found its values on health promotion (Chang & Chiang, 2010; Chiang, Chen, & Chang, 2011). Recently, the team started to use Xbox Kinect and found that the game have its benefits not only on physical but also on emotional functions (Chen, Huang, & Chiang, 2012). According to Chiang (2012), somatosensory video games had its unique characteristics which include immediately feedback, competition, companionship, challenges, close to grandchild and fun, to attract older adults to keep involved. For older adults who do not know how to exercise or do not have motivation to exercise, somatosensory video games have great potentials to develop as useful tools for rehabilitation/health promotion.

METHODOLOGY

Theoretical Framework

Treisman's attenuation theory was used in this study to illustrate the mechanism of the trainings because theories are constructed in order to explain, predict and master phenomena (e.g. relationships, events, or behavior) to make generalizations about observations and to consist of an interrelated, coherent set of ideas and models (Treisman, 1960). The attenuation theory states that unattended stimuli sometimes will be faded and barred unattended inputs from entering awareness when there are layers of sophistication to Broadbent' filter model. According to a previous study, selective attentions will be affected by aging processes because of the distracted by external irrelevant noises (Brink & McDowd, 1999). Therefore, this study proposed that the intervention were tried to add/strength older adults' filters and layers for environmental noises (voices, people, conversations, etc.) and have better selective attentions by practicing somatosensory video games.

Participants

A total of 58 participants were recruited at the beginning of this study but 10 subjects withdrew in the first month and another 10 subjects withdrew in the second month because of health issues and the willingness to join. Non-random purposive sampling was utilized in this study and all participants with disabilities were pre-approved by the medical/managing staffs and signed informed consent forms approved by the human subjects committee at the Taipei Physical Education College (Approval Reference No. 20110023) before participating in the study. In order to complete video game interventions and tests in the study, participants were required to have verbal communication ability and basic physical functions to participate and to be approved by head nurses. After receiving both consent forms from the participant and his/her family member, the elderly were asked to choose to be in the control group or experimental groups. According to their willingness and health condition during the three months period, 8, 8, 10, and 9 older adults completed 4-week experimental and control group and 8-week experimental and control group, respectively (Table 1).

Table 1. Participants' demographics in four groups before intervention (N = 35)

Groups	Gender (M:F)	Age (SD)	MMSE (SD)	Body Weight (SD)
4EG	0:8	77.25 (7.15)	19.50 (5.53)	57.59 (12.88)
4CG	3:5	80.50 (6.61)	21.00 (1.77)	62.03 (15.17)
8EG	2:8	81.20 (6.22)	26.70 (4.08)	56.35 (7.53)
8CG	4:5	77.44 (6.46)	26.44 (2.46)	60.73 (11.95)

4EG: 4-week experimental group
4CG: 4-week control group
8EG: 8-week experimental group

8CG: 8-week control group

Intervention

A quasi-experimental design was used in this study. The two experimental groups voluntarily agreed to complete 4- and 8-week somatosensory video game trainings three sessions per week, for 30 minute each session which included 5-minute warm up, 20-minute interactive gaming, and 5-minute cool down during their free time. Control group did not receive any additional training but maintained regular daily schedules and programs that were provided by the nursing home. In the study, "Xbox-360 Kinect" was selected to be the interventional modality. Three games, mouse mayhem, following the arrow, and matchmaker, were three chosen games in "Dr. Kawashima's Body and Brain Exercises" which were appropriate for older adults with wheelchair (Figure. 1).

(a) (b) (c)

Figure 1. Snapshots of three games while participants were playing in this study: (a) Mouse mayhem; (b) Follow the arrow; (c) Matchmaker

Those games were selected by the exercise- and sport-related professionals and staff who had long-term care professional working experiences with this population. Mouse mayhem is a game to "touch" mice that will pop out from four different pipes located at four different corners on the TV screen. In the game, there are three kinds of mice. Regular green and gold mice are allowed to touch and get points, but the gold mouse with hedgehog hair shall not be touched or points will be deducted. The total time allowed for one game is one minute. In Follow the arrow, red arrows pop out from five different directions and players have to point out those arrows within 5 seconds to get points. Totally 20 questions within one minute shall be answered in each game. Matchmaker uses lots of colorful pop-out figures on the screen and asks players to match the same figures by using both hands to get points. There are 15 pop-outs in each game, and time will be recorded to justify players' performance. Table 2 showed the training plans in this study.

Table 2. Somatosensory video games training plan

Time	Intervention program
week 1	Mouse mayhem x 12
week 2	Mouse mayhem x 5
	Follow the arrow x 5
week 3	Mouse mayhem x 3
	Matchmaker x 3
	Follow the arrow x 5
week 4	Mouse mayhem x 4
	Matchmaker x 4
	Follow the arrow x 4
week 5-week8	Mouse mayhem x 4
(only 8-week group)	Matchmaker x 4
	Follow the arrow x 4

Measurement: Vienna Test System (COG-S9)

The selective attention in this study was measured by Vienna Test system that is based on the theoretical model of Reulecke (1991). Energy, function and precision are three components, which demonstrated their selective attention by showing their demanding energy, performing a task, and the quality of task performance. Examinee uses the response panel as the input device. An animated instruction phase and an error-sensitive practice phase lead on to the task itself. In the test forms with flexible working time the respondent's task is to compare an abstract figure with a model and to decide whether the two are identical. Once the answer has been entered the next item follows automatically. In the test forms with fixed working time a reaction is required only if the figure is identical with the model. Once the presentation time has expired the next item follows automatically. It is not possible to omit an item or to go back to a preceding one.

The majority of reliability being over r = .95. Many studies of different aspects of validity (content validity, convergent and discriminant validity, construct validity, criterion validity) have been carried out. A number of studies carried out in the field of traffic psychology also confirm the validity of the test (Schuhfried, 2010). S9 is one of seven test forms contains very simple, unvarying stimulus questions which have a seven-minute time limit. The scoring of S9 includes total "reactions" (correct and incorrect reactions) and percentage "incorrect reactions". The results includes eight scores which are sum reactions, sum correct reactions, sum incorrect reactions, sum hits, sum correct rejections, percentage incorrect reactions, mean time correct reactions, and mean time incorrect reactions.

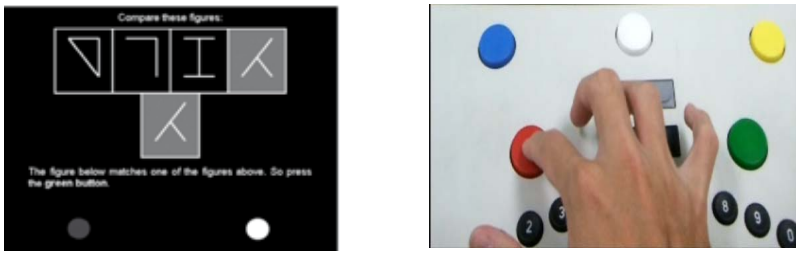

Figure 2. Vienna Test System (a) examination screen; (b) response panel

Measurement: Mini-Mental State Examination (MMSE)

The mini-mental state examination (MMSE) test is a 30-point questionnaire that is used to screen for cognitive impairments and dementia in nursing homes and other older institutions. MMSE is also used to estimate the severity of cognitive impairments at a specific time and to follow the course of cognitive changes in an individual over time. The current standard MMSE form published by Psychological Assessment Resources is based on its original 1975 conceptualization with minor subsequent modifications by the authors and translated into 10 different languages. Within 5 to 10 minutes, examinees are requested to complete questions in five areas included orientation to time, registration to place, attention and calculation, recall, language, repetition and complex commands. According to Folstein, Folstein, and Fanjiang (2001), the scores ranged from 24 to 30 means no cognitive impairment (NCI), 18 to 23 stands for mind cognitive impairment (MCI) and 0-17 represents severe cognitive impairment (SCI). Therefore, it is an effective way to document an individual's cogitative impairments and mental states. In this study, traditional Chinese version were used and administrated by registered nurses.

Data Collection and Analysis

SPSS 18.0 was used for statistical analysis that included descriptive statistics, Chi-square test, Kruskal-Wallis Test, Mann-Whitney U test, Spearman rank correlation coefficients, and Wilcoxon matched-pairs signed-rank test.

RESULTS & DISCUSSION

Demographic Background, Selective Attention and MMSE

According to the results (Table 3), selective attention and mental states demonstrated significant correlation, except percentage incorrect reactions (p < .05). Therefore, four groups were filtered again by their MMSE scores. In this study, we found that participants in both 4-week groups had mind cognitive impairment (MCI) and both 8-week groups had no cognitive impairment (NCI). In order to increase the similarity of the participants' mental states, Table 4 showed the participants' demographics in four groups with their scores of MMSE.

Table 3. Relationship between selective attention and mental states (N = 31)

Items	MMSE
Sum reactions	.61***
Percentage incorrect reactions	-.18
Sum correct reactions	.59**
Sum incorrect reactions	.39*
Mean time correct reactions	-.59***
Mean time incorrect reactions	-.56**
Sum hits	.53**
Sum correct rejections	.51**

*p < .05; **p < .01***p < .001

Table 4. Participants' demographics in four groups with MMSE (N = 31)

Items	Groups	Means (SD)	χ^2
Age(y)	4EG with MCI (n = 6)	74.33 (5.50)	6.42
	4CG with MCI (n = 8)	80.50 (6.61)	
	8EG with NCI (n = 8)	83.13 (5.33)	
	8CG with NCI (n = 9)	77.44 (6.46)	
Weight(kg)	4EG with MCI (n = 6)	60.63 (13.71)	1.13
	4CG with MCI (n = 8)	62.03 (15.17)	
	8EG with NCI (n = 8)	56.75 (7.84)	
	8CG with NCI (n = 9)	60.73 (11.95)	
MMSE	4EG with MCI (n = 6)	20.50 (1.38)	23.35***
	4CG with MCI (n = 8)	21.00 (1.77)	
	8EG with NCI (n = 8)	28.25 (2.43)	
	8CG with NCI (n = 9)	26.44 (2.46)	

***p < .001
4EG: 4-week experimental group
4CG: 4-week control group
8EG: 8-week experimental group
8CG: 8-week control group

Effects of 4-week Interventions for elderly with MCI on Selective Attentions

According to the results (Table 5), 4-week experimental group with MCI demonstrated significant immediate effects in five items of selective attention before and after the intervention (p < .05). This group was also examined differences of scores before and after withdrawal in order to understand the carry-forward effects. Sum reactions, sum correct reactions, sum hits, sum correct rejections had significant regression after one-month withdrawal. In terms of comparison of pre-intervention and after withdrawal, this group only had one significant effect in sum correct reaction. However, in the 4-week control group, participants showed significant increases in sum incorrect reactions and decreases in mean time correct reactions (Table 6).

Table 5. Changes of scores in 4-week experimental group with MCI (n = 6)

Items	Immediate Effects		Carry-forward Effects		Overall Effects	
	z score	ΔX	z score	ΔX	z score	ΔX
Sum reactions	-0.98	+33.7%	-1.68	+55.5%	-0.98	+33.7%
Percentage incorrect reactions	-1.12	+34.5%	-1.68	+66.7%	-1.12	+34.5%
Sum correct reactions	-0.70	+16.0%	-1.26	+37.0%	-0.70	+16.0%
Sum incorrect reactions	-1.47	+118.8%	-2.38*	+144.2%	-1.47	+118.8%
Mean time correct reactions	-0.70	-4.7%	-2.24*	-31.4%	-0.70	-4.7%
Mean time incorrect reactions	-0.70	-9.1%	-1.68	-31.3%	-0.70	-9.1%
Sum hits	-0.14	+2.7%	-1.40	+37.7%	-0.14	+2.7%
Sum correct rejections	-0.70	+22.4%	-1.12	+36.6%	-0.70	+22.4%

*p < .05

Table 6. Changes of scores in 4-week control group with MCI (n = 8)

Items	Immediate Effects		Overall Effects	
	z score	ΔX	z score	ΔX
Sum reactions	-0.98	+33.7%	-1.68	+55.5%
Percentage incorrect reactions	-1.12	+34.5%	-1.68	+66.7%
Sum correct reactions	-0.70	+16.0%	-1.26	+37.0%
Sum incorrect reactions	-1.47	+118.8%	-2.38*	+144.2%
Mean time correct reactions	-0.70	-4.7%	-2.24*	-31.4%
Mean time incorrect reactions	-0.70	-9.1%	-1.68	-31.3%
Sum hits	-0.14	+2.7%	-1.40	+37.7%
Sum correct rejections	-0.70	+22.4%	-1.12	+36.6%

Effects of 8-week Interventions for elderly with NCI on Selective Attentions

According to the results (Table 7), the 8-week experimental group with NCI demonstrated significant immediate effects in seven items of selective attention before and after the intervention ($p < .05$). In order to understand the carry-forward effects, the differences of selective attention before and after withdrawal were examined and found that 8 items of selective attention did not have significant regression and demonstrate its carry-forward effects ($p < .05$). In terms of comparison of pre-intervention and after withdrawal, 8-week group with NCI demonstrated significant overall effects, except sum correct reaction ($p < .05$). In the 4-week control group, participants did not show any significant difference in all measurements (Table 8).

Table 7. Changes of scores in 8-week experimental group with NCI (n = 8)

Items	Immediate Effects		Carry-forward Effects		Overall Effects	
	z score	ΔX	z score	ΔX	z score	ΔX
Sum reactions	-2.38*	+33.2%	-0.56	-1.8%	-2.10*	+30.8%
Percentage incorrect reactions	-2.10*	-42.5%	-1.12	-16.7%	-2.10*	-52.1%
Sum correct reactions	-2.52*	+44.6%	-0.42	+0.7%	-2.52*	+45.5%
Sum incorrect reactions	-1.75	-40.8%	-0.85	-22.6%	-1.40	-54.2%
Mean time correct reactions	-2.38*	-32.5%	-0.28	+1.0%	-2.17*	-31.8%
Mean time incorrect reactions	-2.52*	-42.3%	-0.84	+18.8%	-1.54	-31.5%
Sum hits	-2.52*	+39.8%	-0.14	+1.9%	-2.24*	+42.5%
Sum correct rejections	-2.38*	+46.7%	-0.35	+0.1%	-2.52*	+46.9%

*$p < .05$

Table 8. Changes of scores in control group with NCI (n = 9)

Items	4-weeks later		8-weeks later	
	z score	ΔX	z score	ΔX
Sum reactions	-0.30	-32.7%	-0.42	-26.8%
Percentage incorrect reactions	-0.06	-15.3%	-0.53	-11.7%
Sum correct reactions	-0.77	-13.7%	-0.30	-0.2%
Sum incorrect reactions	-0.24	-58.9%	-1.05	-63.6%
Mean time correct reactions	-1.24	+51.1%	-0.89	+40.6%
Mean time incorrect reactions	-1.24	+96.2%	-1.00	+44.8%
Sum hits	-0.18	-29.1%	-0.65	-38.0%
Sum correct rejections	-0.06	+0.7%	-0.42	+28.2%

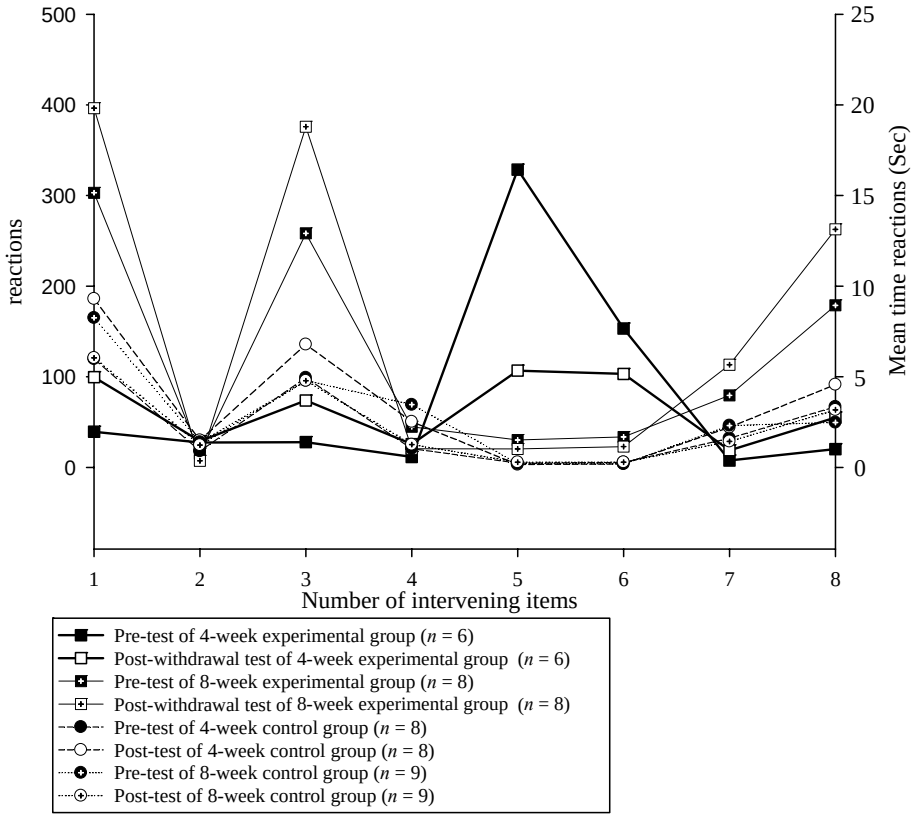

Figure3. Overall Effects. 1. Sum reactions; 2. Percentage incorrect reactions; 3. Sum correct reactions; 4. Sum incorrect reactions; 5. Mean time correct reactions; 6. Mean time incorrect reactions; 7. Sum hits; 8. Sum correct rejections. a, 8-week experimental group with NCI (n = 8) improved significantly on number 1,2,3,5,7,8 (p < .05). b, 4-week experimental group with MCI (n = 6) improved significantly only on number 3.

Overall Effects of 4-week and 8-week Interventions on Selective Attentions

In order to understand the impacts of interventions with different durations, three groups were examined their differences in 8 items (Figure 3). Sum reactions, sum correct reactions, sum hits, sum correct rejections, percentage incorrect reactions, mean time correct reactions, and mean time incorrect reactions are 7 items had significant improvements in 8-week experimental group with NCI. Sum correct reactions were the only one item significantly changed in 4-week experimental group with MCI. In the control group, there is no significant improvement in all 8 items.

CONCLUSIONS

In this study, we found that somatosensory video game trainings can significantly improved some aspects of selective attention on elderly with MCI and had limited carry-forward and overall effects with 4-week intervention. However, 8-week intervention had much better promising outcomes on immediate, carry-forward and overall effects on elderly with NCI. The findings suggested that more than 8 weeks somatosensory video game interventions are valuable to promote selective attention for older adults. However, there is still a strong need to continue somatosensory video game related research on older adults with different levels of MMSE. Furthermore, continuing innovative clinical-/intervention-type studies and practice-based somatosensory video game interventions in different settings (e.g. community, home-based) are recommended to explore sustainable health promotion strategies for this aged and aging society.

Several matters arising from the research methodology may have impacted on these final results. First, this study only can gather information from four short stays and the lack of directly empirical long-term data (e.g. real interdependent homes) to support the model may be criticized due to the nature of exploratory study design. Nevertheless, the study still provides valuable contributions to stipulate possible practical solutions for non-working time and services in the interdependent homes by having solid theoretical framework support and critical literature review. Secondly, another potential challenge would question on the legitimacy of borrowing concepts of complexity theory as a metaphors from the physical and biological sciences. In order to overcome

this challenge, a great number of previous studies in health-related and educational professions on complexity theory have been critically reviewed. Satisfactory in predicting solutions on multidisciplinary collaborations was found because complexity theory provides a new angle in looking at how complex environment and structures form, adapt, and change. The academic nature of the research was emphasized in this study.

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